Project Title: Predicting Potential Downgradient Groundwater Quality Changes from In-Situ Recovery of Uranium at the Dewey-Burdock Site Using Core Data and Reactive Transport Modeling

Abstract: The EPA, Region 8, Underground Injection Control (UIC) Program is currently preparing a draft permit for the Powertech (USA) Incorporated (Powertech) proposed Dewey Burdock uranium in-situ recovery (ISR) site in southwest South Dakota. The Region 8, UIC Program is tasked under the Safe Drinking Water Act with developing the first draft uranium ISR Class III injection well permit ever to be issued directly by the EPA. The permitting process entails issuing a UIC draft permit for injection activity and a draft aquifer exemption decision to allow injected lixiviant to mobilize uranium through the ore-bearing portions of an underground source of drinking water (USDW). The Region 8, UIC Program is seeking continued support from the EPA Office of Research and Development and the U.S. Geological Survey in establishing sound, science-based, criteria and strategies to support the aquifer exemption evaluation and decision-making process to ensure the long-term protection of groundwater resources outside the aquifer exemption boundary. This 2014 Regional Applied Research Effort (RARE) proposal builds upon work completed under a 2010 RARE project. Project work will involve the collection and analysis of cores from areas downgradient of the proposed ISR wellfields and use this information for long-term protection of groundwater quality under a variety of restoration scenarios using reactive transport modeling.

1. Background: The uranium ISR process extracts uranium by injecting a lixiviant in an ISR wellfield to dissolve uranium from ore deposits located within the ore-bearing aquifer. This process changes the pre-existing aquifer geochemistry and mobilizes uranium into a solution that flows to recovery wells. The EPA UIC Program is tasked with approving an aquifer exemption boundary surrounding each ISR wellfield beyond which any changes in groundwater quality are violations of the UIC permit. The aquifer exemption decision has a direct impact on Safe and Sustainable Groundwater Resources. Under a 2010 RARE project, USGS developed a general conceptual model and 1D/2D reactive transport models (groundwater flow and geochemistry) for uranium roll-front formation, current groundwater conditions, and simulations of uranium ISR, restoration, and long-term transport based on pre-mining data.

How Project Will Provide New Knowledge, Data, and Tools Needed: Analyses of additional core data along with fate and transport modeling of mobilized constituents down gradient from ore-bodies will provide tools for evaluating the potential impact of uranium ISR activities on the downgradient USDWs after groundwater restoration within the wellfield.

2. Project History: Under a 2010 RARE project, the USGS determined that actual downgradient solid-phase data (from cores) are critical for developing and calibrating reactive transport simulations of potential uranium movement (and other dissolved constituents) away from uranium in-situ recovery sites. The 2014 RARE project will provide the necessary data on potential rock/water interactions at the Dewey-Burdock site to create better predictions of long-term groundwater geochemistry downgradient from the mining and restored ore-bodies.

Links to RARE Program goals: The Region 8, UIC Program has been working closely with the South Dakota Department of Environment and Natural Resources and the Nuclear Regulatory Commission, building federal and state partnerships during the technical evaluation of Powertech's Dewey Burdock ISR applications submitted to each respective agency. The 2010 RARE project has facilitated this partnership-building effort; the 2014 RARE project will strengthen these existing partnerships. The Region 8, UIC Program is currently engaged in providing informational web conferences related to the tribal consultation process required under the National Historic Preservation Act. Work proposed under this 2014 RARE project will provide technical support to address questions the tribes are asking about impact to groundwater, as well as providing technical support to the Region 8 UIC Program, the NRC and the SD DENR as they move forward with addressing public concerns about the impacts of ISR activities on groundwater quality.

3. Research Objectives: The objectives of this project include:

a) Providing strategies for better understanding the most probable fate and transport of uranium and other constituents remaining in groundwater after completion of ISR operations, and
b) Identifying UIC permit requirements that protect the local groundwater, such as aquifer exemption boundaries and appropriate locations and time frames for groundwater monitoring, based on the fate and transport model results.

Recently there has been increased scrutiny of the EPA's aquifer exemption decision-making process across the Regions and the impact of aquifer exemptions on safe and sustainable groundwater resources. A methodology is needed to better inform the EPA aquifer exemption evaluation process. This project will result in development and verification of a methodology to 1) evaluate whether wellfield groundwater restoration targets will prevent changes in groundwater quality downgradient of the aquifer exemption boundary, and 2) evaluate solid-phase aquifer geochemistry and its potential for mitigating groundwater quality changes downgradient of the ISR wellfield before the aquifer exemption boundary is reached.

4. Research Approach: This 2014 research project proposes strategies for addressing the following questions:

a) Given possible groundwater quality scenarios at the end of ISR restoration efforts, what reactions could take place downgradient of the uranium recovery zones?
b) What is the solid-phase geochemistry down gradient from the recovery zones and how does this geochemistry influence #1?
c) With the results from a) and b), what is the prediction of long-term fate and transport of any groundwater contaminants away from the uranium recovery zones?

The prediction of long-term geochemical changes in areas downgradient of uranium ore zones will be compared to current geochemistry and likely reactions that control uranium distribution in the groundwater and the solid phase. In addition, these likely reactions (i.e., uranium sorption and/or precipitation) will be tested in a laboratory setting for use as input to reactive transport models. Post-restoration, the USGS will assist in reactive transport model calibration/evaluation under internal USGS funding, if available.

5. Research Results and Products

A. New data	Solid-phase geochemistry from the monitoring well ring around the uranium ISR wellfield. No core data is currently available in these areas. This information is key to predicting future groundwater quality as restoration fluids in the recovery zones begin to contact the down gradient solid phase.
B. Tools	Reactive transport modeling is a tool for determining future groundwater quality. The inclusion of new solid-phase data will improve the predictive power of this tool. Confirmation of potential geochemical reactions will be testing in the laboratory.
C. Regulatory decision support and Program support	2014 project work will support continued efforts of EPA, NRC and DENR in the technical evaluation of the uranium ISR restoration requirements. The 2014 focus will be assessment of long-term groundwater quality down gradient of the uranium ISR zones. Results will evaluate what levels of restoration are necessary to meet EPA groundwater quality requirements at the compliance points. This information will also be used in addressing concerns identified during the draft permit public review process.
D. Enforcement support	Permit requirements will quantify measureable permit limits that are easily translatable into compliance monitoring /verification and enforcement actions, if permit limits are violated. Reactive transport modeling will provide information on necessary restoration levels that will translate into longer-term compliance on groundwater quality.
E. Reports F. Models G. Scientific Articles	2014 project work will be documented and communicated in presentations at technical conferences, scientific reports, and deliverables to the EPA in order to assure effective research communication planning. Deliverables will include 1) report on additional USGS/EPA core data (solid-phase geochemistry), 2) report on laboratory experiments for uranium sorption and precipitation, and 3) report on predictive reactive transport modeling at the EPA compliance points, with information on appropriate groundwater monitoring locations and time frames.

6. Proposed Budget: $ 199,000

The project will require a year of funding for new data collection (cores and laboratory analyses) and reactive transport modeling. Salaries are for USGS staff; contracts include analytical support from ORD. The project may be extended an extra year without further cost increase to include final data compilation and report preparation.

Categories	Cost	Categories	Cost
Salaries	$100,000	Laboratory Supplies	$ 2,000
Contracts	$ 10,000	Publications	$ 2,000
Core drilling/collection/analyses	$ 85,000	**Total**	**[=SUM(ABOVE)]**

7. Project Timeline

April 2014	Identify funding vehicle; initiate interagency agreement. The Region 8 Lead Technical Contact will work closely with the ORD Principal Investigator to facilitate communication between ORD and USGS while the interagency agreement is developed and finalized.
May 2014	Initiate project by finalizing Project Work Plan and Quality Assurance Project Plan for review by ORD Principal Investigator. The Region 8 Lead Technical Contact will work closely with the ORD Principal Investigator to jointly manage project activities, goals, and completion of research products.
June 2014	Drill and collect core in strategic areas around proposed wellfield locations, independent of Powertech's monitoring well installation. Begin analyses on core.
During monitoring well ring installation	Collect any additional core made available by Powertech and submit for laboratory analyses. Timing is contingent upon issuance of Final UIC Permit. If monitoring well ring core is not available, core collected by USGS/EPA will suffice.
Once laboratory analyses are complete	Use the new data in predictive reactive transport models.
January – February 2015	Complete deliverables under 5.E-G.
March 2015	Deliverables in 5.E-G in review.
April 2015	Interagency agreement will include option to extend project an additional year, if needed, in order to finalize reports and to include possible delays in the drilling schedule.